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101

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER

1406/18

U.S. APPLICATION NO. (If known, see 37 CFR 1.5

09/936771

INTERNATIONAL APPLICATION NO.

PCT/EP01/00494

INTERNATIONAL FILING DATE

17 January 2001 (17.01.01)

PRIORITY DATE CLAIMED

17 January 2000 (17.01.00)

TITLE OF INVENTION CDMA RECEIVER

APPLICANT(S) FOR DO/EO/US INFINEON TECHNOLOGIES AG; DOETSCH, Markus; KELLA, Tideya;
SCHMIDT, Peter; JUNG, Peter; PLECHINGER, Joerg and SCHNEIDER, Michael

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND or SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information include:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1
12. ☐ An assignment document for recording. A separate cover sheet
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

Copy of first page of published PCT application; Copy of International Search Report


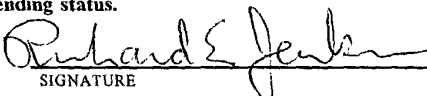
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I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231. Katrina T. Holland, Lillian S. Glenn, Amy J. Martin, Karen S. Flynn, Paige E. Snyder, Shaylor E. Dunn, April N. Williams

COPY

JC16 Rec'd PCT/PTO SEP 14 2001

U.S. PATENT APPLICATION NO. 097/936771 INTERNATIONAL APPLICATION NO. PCT/EP01/00494	ATTORNEY'S DOCKET NUMBER 1406/18																									
21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a) (2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =		CALCULATIONS PTO USE ONLY <table style="width: 100%;"> <tr> <td style="width: 60%; text-align: right;">\$</td> <td style="width: 40%; text-align: right;">860.00</td> </tr> </table>	\$	860.00																						
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<table style="width: 100%;"> <tr> <td style="width: 20%;">CLAIMS</td> <td style="width: 20%;">NUMBER FILED</td> <td style="width: 20%;">NUMBER EXTRA</td> <td style="width: 20%;">RATE</td> <td style="width: 20%;">\$</td> </tr> <tr> <td>Total claims</td> <td>13 -20 =</td> <td>0</td> <td>x \$18.00</td> <td>\$ 0.00</td> </tr> <tr> <td>Independent claims</td> <td>1 -3 =</td> <td>0</td> <td>x \$80.00</td> <td>\$ 0.00</td> </tr> <tr> <td colspan="4">MULTIPLE DEPENDENT CLAIM(S) (if applicable)</td> <td>+ \$270.00</td> </tr> <tr> <td colspan="4">TOTAL OF ABOVE CALCULATIONS =</td> <td>\$ 860.00</td> </tr> </table>		CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$	Total claims	13 -20 =	0	x \$18.00	\$ 0.00	Independent claims	1 -3 =	0	x \$80.00	\$ 0.00	MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ \$270.00	TOTAL OF ABOVE CALCULATIONS =				\$ 860.00
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a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>860.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>50-0426</u> . A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.																										
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SEND ALL CORRESPONDENCE TO: Richard E. Jenkins JENKINS & WILSON, P.A. Suite 1400 University Tower 3100 Tower Boulevard Durham, NC 27707 USA																										
 25297 PATENT TRADEMARK OFFICE		 SIGNATURE Richard E. Jenkins NAME <u>28,428</u> REGISTRATION NUMBER																								

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09/936771
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April N. Williams

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Doetsch et al.

Group Art Unit: Not Assigned

Serial No.: Not Assigned

Examiner: Not Assigned

Filed: Herewith

Docket No.: 1406/18

For: CDMA RECEIVER

PRELIMINARY AMENDMENT

Honorable Commissioner for Patents
BOX PCT
Washington, D.C. 20231

Dear Sir:

Kindly amend the subject application as follows:

IN THE SPECIFICATION:

Please insert the paragraph heading on page 1 of the English translation of the subject application, before line 5, as follows:

--Technical Field --.

Please insert the paragraph heading on page 1 of the English translation of the subject application, before line 10, as follows:

--Related Art --.

Please insert the paragraph heading on page 3 of the English translation of the subject application, before line 33, as follows:

--Summary of the Invention --.

Please insert the paragraph heading on page 6 of the English translation of the subject application, before line 7, as follows:

--Brief Description of the Drawings--.

Please insert the paragraph heading on page 6 of the English translation of the subject application, before line 27, as follows:

--Detailed Description of the Invention--.

IN THE CLAIMS:

Please delete the paragraph heading "Patent Claims" on page 13 of the English translation of the subject application, and insert in place thereof the paragraph heading on page 13 of the English translation of the subject application, line 1, as follows:

--CLAIMS--

Please insert the paragraph heading on page 13 of the English translation of the subject application, after the above-noted heading and before claim 1, the following:

-- What is claimed is: --.

Please amend claims 1-13 as follows:

1. (Amended) CDMA receiver for receiving a CDMA signal, which is transmitted at the chip clock rate from a transmitter via various signal paths of a physical transmission channel, in a multi-subscriber environment having:

- (a) a receiving device for receiving the CDMA signal;
- (b) a Rake receiving circuit having a number of parallel-connected delay devices for detection of the signal components of the CDMA signal which are transmitted via the various signal paths;
- (c) a channel estimation circuit for estimating channel coefficients h of a transmission channel H by means of a predetermined reference data sequence which is contained in the received CDMA signal;
- (d) a weighting coefficient calculation device for calculating weighting coefficients m for the various signal components of the CDMA signal as a function of the estimated channel coefficients h and of stored spreading and scrambling codes;
- (e) a weighting circuit for weighting the signal components with the calculated weighting coefficients m ; and having
- (f) a combiner for combining the weighted signal components to form an estimated received data signal.

2. (Amended) CDMA receiving according to Claim 1, wherein the weighting coefficient calculation device is connected to a memory device.

3. (Amended) CDMA receiving according to Claim 1, wherein spreading codes C_{SP} of the subscriber and scrambling codes C_{SC} from the transmitter are stored in the memory device.

4. (Amended) CDMA receiver according to claim 1, wherein the combiner is an adder for adding the weighted signal components.

5. (Amended) CDMA receiver according to claim 1, wherein the reference data sequence is processed by the channel estimation circuit at the chip clock rate T_C .

6. (Amended) CDMA receiving according to claim 1, wherein the delay devices of the Rake receiving circuit delay the received CDMA signal by an associated time delay τ differing by precisely one chip clock cycle T_C between the various delay devices.

7. (Amended) CDMA receiver according to claim 1, wherein the receiving device is a receiving antenna, which is followed by a sampling circuit for sampling the CDMA receiving signal.

8. (Amended) CDMA receiver according to claim 1, wherein an output circuit is provided for outputting the reference data sequence from the received CDMA received signal.

9. (Amended) CDMA receiver according to claim 1, wherein the weighting circuit comprises a large number of multiplication circuits, which are each followed by a delay device.

10. (Amended) CDMA receiver according to claim 1, wherein a buffer store is provided for buffer storing the sampled received data from the CDMA received signal.

11. (Amended) CDMA receiver according to claim 1, wherein the channel estimation circuit is a DSP processor.

12. (Amended) CDMA receiver according to claim 1, wherein the weighting coefficient calculation device is a DSP processor.

13. (Amended) CDMA receiver according to claim 2, wherein the memory device is an RAM memory.

REMARKS

The amendments to the specification as set forth above are intended to clarify and set apart the various sections of the subject application.

The amendments to the claims as set forth above are intended to remove all multiple dependent claims from the subject application and to more particularly point out and distinctly claim the subject invention.

Attached hereto is a marked-up version of the specification and claims 1-13, which illustrates all of the changes made to the specification and claims pursuant to 37 CFR §1.121. The attached page is captioned "**Version With Markings To Show Changes Made**". Deleted language is bracketed and added language is underlined.

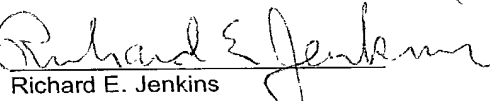
The Commissioner is hereby authorized to charge any deficiencies or credit any overpayments in connection with the filing of this correspondence to Deposit Account No. **50-0426**.

Respectfully submitted,

JENKINS & WILSON, P.A.

Date: 9-14-91

By:


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3100 Tower Boulevard
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1406/18 REJ/lsg



25297

PATENT TRADEMARK OFFICE

Serial No.: Not yet assigned

Version With Markings To Show Changes Made

IN THE SPECIFICATION:

The paragraph heading has been inserted on page 1 of the English translation of the subject application, before line 5, as follows:

Technical Field

The paragraph heading has been inserted on page 1 of the English translation of the subject application, before line 10, as follows:

Related Art

The paragraph heading has been inserted on page 3 of the English translation of the subject application, before line 33, as follows:

Summary of the Invention

The paragraph heading has been inserted on page 6 of the English translation of the subject application, before line 7, as follows:

Brief Description of the Drawings

The paragraph heading has been inserted on page 6 of the English translation of the subject application, before line 27, as follows:

Detailed Description of the Invention

IN THE CLAIMS:

The paragraph heading has been inserted on page 13 of the English translation of the subject application, before line 1, as follows:

CLAIMS

The paragraph heading has been inserted on page 13 of the English translation of the subject application, before claim 1, as follows:

What is claimed is:

1. (Amended) CDMA receiver for receiving a CDMA signal, which is transmitted at the chip clock rate from a transmitter via various signal paths of a physical transmission channel, in a multi-subscriber environment having:

- (a) a receiving device [(1)] for receiving the CDMA signal;
- (b) a Rake receiving circuit [(6)] having a number of parallel-connected delay devices [(7₁-7_n)] for detection of the signal components of the CDMA signal which are transmitted via the various signal paths;
- (c) a channel estimation circuit [(20)] for estimating channel coefficients h of a transmission channel H by means of a predetermined reference data sequence which is contained in the received CDMA signal;

- (d) a weighting coefficient calculation device for calculating weighting coefficients m for the various signal components of the CDMA signal as a function of the estimated channel coefficients h and of stored spreading and scrambling codes;
- (e) a weighting circuit [(12)] for weighting the signal components with the calculated weighting coefficients m ; and having
- (f) a combiner [(15)] for combining the weighted signal components to form an estimated received data signal.

2. (Amended) CDMA receiving according to Claim 1, [characterized in that] wherein the weighting coefficient calculation device [(12)] is connected to a memory device [(23)].

3. (Amended) CDMA receiving according to Claim 1 [or 2, characterized in that], wherein spreading codes C_{SP} of the subscriber and scrambling codes C_{SC} from the transmitter are stored in the memory device [(23)].

4. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the combiner [(15)] is an adder for adding the weighted signal components.

5. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the reference data sequence is processed by the channel estimation circuit [(20)] at the chip clock rate T_c .

6. (Amended) CDMA receiving according to [one of the preceding claims, characterized in that] claim 1, wherein the delay devices [(7₁-7_n)] of the Rake receiving circuit [(6)] delay the received CDMA signal by an associated time delay τ , with the time delay τ differing by precisely one chip clock cycle T_c between the various delay devices.

7. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the receiving device [(1)] is a receiving antenna, which is followed by a sampling circuit for sampling the CDMA receiving signal.

8. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein an output circuit [(17)] is provided for outputting the reference data sequence from the received CDMA received signal.

9. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the weighting circuit [(13)] comprises a large number of multiplication circuits [(10₁-10_n)], which are each followed by a delay device [(7₁-7_n)].

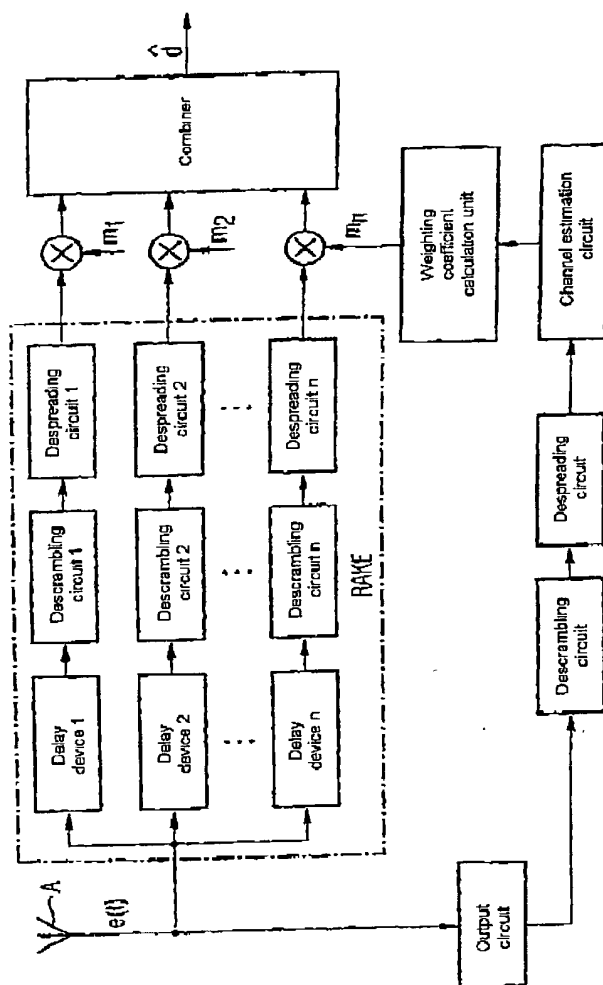
10. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein a buffer store is provided for buffer storing the sampled received data from the CDMA received signal.

11. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the channel estimation circuit [(20)] is a DSP processor.

12. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 1, wherein the weighting coefficient calculation device [(12)] is a DSP processor.

13. (Amended) CDMA receiver according to [one of the preceding claims, characterized in that] claim 2, wherein the memory device [(23)] is an RAM memory.

FIG 4 Prior art



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Description

CDMA receiver

- 5 The invention relates to a CDMA receiver for receiving a CDMA signal, which is transmitted at the chip clock rate from a transmitter via various signal paths of a physical transmission channel.
- 10 The CDMA method (CDMA: Code Division Multiple Access) is a channel access method which is used in cellular systems, in particular in the mobile radio field. In this case, a narrowband signal is spread by means of a code to form a broadband signal. The subscriber signals
- 15 from those subscribers who are active at the same time in the same subscriber frequency band are band-spread by the application of subscriber-specific CDMA codes. In the CDMA method, a fingerprint, which is as unique as possible, is printed onto each data symbol. This can
- 20 be achieved by using orthogonal OVSF coders.

Figure 1 shows one cell in a cellular mobile radio system, in which three subscribers or users U1, U2, U3 are located within one mobile radio cell and receive a

25 CDMA transmitted signal from the base station BS. A subscriber U receives a CDMA signal from the base station BS via a physical channel path H. The physical channel H comprises a large number of signal propagation paths which occur, for example, owing to

30 reflections or signal scatter.

Figure 2 shows a simple model for data transmission from the base station to a subscriber U. A data stream $d(t)$ is produced in the base station, and is spread,

35 coded and scrambled to form a transmitted signal $S(t)$ by means of a CDMA transmitter in the base station. The transmitted signal passes via the physical channel H as a received signal $e(t)$ to the subscriber's CDMA receiver. In the CDMA receiver, the received signal is

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descrambled and despread or decoded to form an estimated data stream $\hat{d}(t)$, which normally corresponds to the data stream $d(t)$ which the CDMA transmitter receives.

5

Figure 3 shows a CDMA transmitter according to the prior art. The transmitter receives data streams d_1 , d_2 , ... d_k , which are intended for different subscribers, from different data sources in parallel.

10 The data streams d are spread and coded in an associated spreading circuit, using OVSF codes that are orthogonal in pairs. The spread and coded data streams are fed to an adder. The adder superimposes the various spread and coded data streams, and passes the
15 integrated data stream on to a scrambling circuit. The superimposed data stream is scrambled and is emitted from the base station BS as the transmitted data stream s to the subscribers U . The scrambling process is used by the subscriber to identify the base station BS.

20

Figure 4 shows a CDMA receiver according to the prior art. The CDMA received signal $e(t)$ received by the subscriber U via a receiving antenna A is fed to a Rake receiving circuit. The Rake receiving circuit has a
25 number of signal paths which run in parallel with one another and each comprise a delay device, a descrambling circuit and a despread circuit. The various parallel-connected signal paths are also referred to as Rake fingers. The Rake receiving circuit
30 is used to detect the various signal components of the transmitted CDMA transmitted signal, which are produced by the various signal paths of the physical transmission channel. In this case, the delay device takes account of the various signal propagation time
35 delays on the various signal paths of the transmission channel. The delay times in the delay devices are adjustable, and can be adapted to the transmission channel during reception of the CDMA signal. The various signal components in the CDMA received signal

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are descrambled in the various Rake fingers, and are then despread by means of an OVSF code. On the output side, the CDMA signal components detected by the Rake fingers are multiplied by weighting coefficients by means of multipliers, and are converted in a combiner into an estimated data signal \hat{d} . The combiner is an addition circuit which adds the various weighted signal components. The weighting coefficients m are calculated in a weighting coefficient calculation unit on the basis of estimated channel coefficients h , which are determined by a channel estimation circuit. This is done by outputting a reference data sequence by means of an output circuit from the CDMA received signal $e(t)$, which sequence is descrambled in a descrambling circuit and, after despread in a despread circuit, is passed to the channel estimation circuit.

The CDMA receiver according to the prior art as shown in Figure 4 has the disadvantage, however, that it is impossible to eliminate signal interference between different subscribers or users within one mobile radio cell. The CDMA receiver illustrated in Figure 4 is suitable only for single subscriber detection, in which case the intersymbol interference and the multiple-access interference between the subscribers cannot be overcome, so that only a low spectrum efficiency can be achieved. The CDMA receiver shown in Figure 4 has no data relating to the spreading codes C_{sv} of the other subscribers in the cell. It thus cannot take any account of or suppress interference caused by the signals transmitted by other subscribers in that cell.

The object of the present invention is thus to provide a CDMA receiver in which signal interference which is caused by signals transmitted by other subscribers is overcome.

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According to the invention, this object is achieved by a CDMA receiver having the features specified in Patent Claim 1.

- 5 The invention provides a CDMA receiver for receiving a CDMA signal, which is transmitted at the chip clock rate from a transmitter via various signal paths of a physical transmission channel, in a multi-subscriber environment, having a receiving device for receiving a
10 CDMA signal, having a Rake receiving circuit with a number of parallel-connected delay devices for detection of signal components of the CDMA signal which are transmitted via different signal paths, having a channel estimation circuit for estimating
15 channel coefficients of a combined transmission channel by means of a predetermined reference data sequence which is contained in the received CDMA signal, having a coefficient calculation device for calculating weighting coefficients for the various signal
20 components of the CDMA signal as a function of the estimated channel coefficients and of stored spreading and scrambling codes, having a weighting circuit for weighting the signal components with the calculated weighting coefficients,
25 and having a combiner for combining the weighted signal components to form an estimated received data signal for further data processing.

- One advantage of the CDMA receiver according to the
30 invention is that the conventional Rake receiver structure can be retained.

- The CDMA receiver according to the invention effectively overcomes signal interference between
35 different subscribers in one cell. This allows the number of subscribers within one cell to be increased, and the data can be transmitted at a higher data rate from the base station to the subscribers. The suppression of multi-access interference also reduces

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the bit error rate by means of the CDMA receiver according to the invention.

The weighting coefficient calculation device is preferably connected to a memory device.

The memory device preferably stores spreading codes for the other subscribers as well as the scrambling code for the transmitter.

10

In one preferred embodiment, the combiner is an adder for addition of the weighted signal components.

The reference data sequence is preferably processed by the channel estimation circuit at the chip clock rate.

15

The delay devices in the Rake receiving circuit delay the reception of the CDMA signal with an associated time delay, with the time delay between the various delay devices preferably differing by precisely one chip clock cycle.

20

The receiving device preferably has a receiving antenna and a sampling circuit for sampling the received CDMA signal.

25

Furthermore, an output circuit is preferably provided for outputting the reference data sequence from the received CDMA signal.

30

In one preferred embodiment of the CDMA receiver according to the invention, the weighting circuit comprises a large number of multiplication circuits, which are each followed by a delay device.

35

In one particularly preferred embodiment of the CDMA receiver according to the invention, a buffer store is provided for buffer storage of the sampled CDMA received data.

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The channel estimation circuit and the weighting coefficient calculation unit are preferably provided by a sequence in an appropriate algorithm in a DSP processor.

A preferred embodiment of the CDMA receiver according to the invention will be described in the following text in order to explain features which are essential to the invention, with reference to the attached figures, in which:

Figure 1 shows a schematic illustration of a mobile radio cell with a number of subscribers;

Figure 2 shows a simple data channel model;

Figure 3 shows a CDMA transmitter according to the prior art;

Figure 4 shows a CDMA receiver according to the prior art; and

Figure 5 shows one preferred embodiment of the CDMA receiver according to the invention.

As can be seen from Figure 5, the CDMA receiver according to the invention has a receiving antenna 1, which is used for receiving a CDMA signal which is transmitted from a base station and is received as the received signal $e(t)$ by the antenna 1. The antenna 1 passes the received CDMA signal $e(t)$ via a line 2 to an output node 3, which is connected via a line 4 to a signal input 5 of a Rake receiving circuit 6. The Rake receiving circuit 6 has a large number of delay devices $7_1, 7_2, 7_n$. The delay devices 7 are connected in parallel with one another via internal signal lines $8_1, 8_2, 8_n$, with the signal lines 8 being connected to the signal input 5 of the Rake receiving circuit 6. The

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delay devices 7_1-7_n are connected on the output side via lines 9_1-9_n to multiplication circuits 10_1-10_n . The multiplication circuits 10_1-10_n respectively multiply the signal components of the CDMA received signal which are emitted from the delay devices 7_1-7_n by respective weighting coefficients m_1-m_n , which are emitted via lines 11_1-11_n from a weighting coefficient calculation device 12. The multiplier circuits 10_1-10_n together form a weighting circuit 13. The signal components emitted by the multipliers 10_1-10_n are emitted via lines 14_1-14_n to a combiner 15, which combines the various weighted signal components to form an estimated received data signal $\hat{d}(t)$ which is emitted via a data line 16 for further data processing in the receiver.

15

The CDMA signal $e(t)$ received via the antenna 1 contains a reference data sequence which is output at the output point 3 by means of an output circuit 17. The output circuit 17 is for this purpose connected via a line 18 to the output node 3. The reference data sequence which is output by the output circuit 17 is supplied via a line 19 directly to a channel estimation circuit 20. The channel estimation circuit estimates the channel coefficients h of the physical transmission channel H by means of the output reference data sequence, and emits the determined channel coefficients h via a line 21 to the weighting coefficient calculation device 12.

The weighting coefficient calculation device 12 is connected via a memory read line 22 to a memory device 23. The spreading codes C_{sp} for the other subscribers U as well as the scrambling code C_{sc} for the base stations BS are stored in the memory device 23. The weighting coefficient calculation device 12 calculates the weighting coefficients m for the various signal components of the CDMA signal as a function of the estimated channel coefficients h , and of the stored spreading codes C_{sp} and scrambling codes C_{sc} . The

The estimated data vector thus becomes:

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$$\bar{d} = [M][H][C_{sp}][C_{sc}] \cdot \bar{d} \quad (4)$$

Since the physical transmission channel (τ) and the spreading circuit and scrambling circuit are regarded as a combined channel, the coefficient matrix for the combined channel H' becomes:

$$[H'] = [H][C_{sp}][C_{sc}] \quad (5)$$

The received estimated data vector \bar{d} thus depends on the coefficient matrix for the receiver M and on the coefficient matrix H' for the combined channel.

$$\bar{d} = [M] \cdot [H'] \cdot \bar{d} \quad (6)$$

In the case of an assumed, ideally estimated physical transmission channel, the coefficients m of the receiver matrix M must be set by the weighting coefficient calculation device 12 such that:

$$[M] \cdot [H'] \rightarrow I \quad (7)$$

where I corresponds to the unit matrix.

The signal coefficients h of the physical transmission channel H are received by the weighting coefficient calculation device 12 from the channel estimation circuit 20 via the line 21. The spreading coefficients C_{sp} of the orthogonal OVSF codes of the other subscribers are stored in the memory 23, and can be read by the weighting coefficient calculation device 12 via the line 22.

The scrambling code C_{sc} of the base stations BSs is likewise stored in the memory 23, and is read by the weighting coefficient calculation device 12 in order to calculate the channel coefficients for the combined channel H' .

The weighting coefficient calculation device 12 contains a processor, which carries out the calculation defined in equation 7 and calculates the weighting coefficients m of the receiver in such a manner that

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the product of the receiver matrix M and of the channel coefficient matrix H' of the combined channel approximates to the unit matrix I .

5 As can be seen by comparing Figure 4, which shows the CDMA receiver according to the prior art, and Figure 5, which shows the CDMA receiver according to the invention, the circuitry of the CDMA receiver according to the invention is less complex. The Rake receiving
10 circuit 6 of the CDMA receiver according to the invention comprises only the delay devices 7_1-7_n , and does not contain any descrambling circuits or despreading circuits for the respective signal components. Furthermore, the output circuit 17 in the
15 CDMA receiver according to the invention is connected directly to the channel estimation circuit 20 via the line 19. The reference data sequence which is output by the output circuit 17 is processed by the channel estimation circuit 20 using the chip clock rate T_c and
20 not using the symbol data clock rate T_D . The delay devices 7_1-7_n in the Rake receiving circuit 6 delay the received CDMA signal $e(t)$ by an associated time delay τ , with the time delay τ differing by precisely one chip clock cycle T_c between the various delay devices 7_1-7_n .

25 The CDMA receiver according to the invention has the memory 23, in which the spreading codes C_{SP} of all the subscribers and the scrambling codes C_{SC} of the base stations BS are stored. This means that the CDMA
30 receiver according to the invention can also take into account the orthogonal spreading codes of the other subscribers in the cell, and hence the signal received from them, when calculating the weighting coefficients m . In the process, the weighting coefficient
35 calculation device 12 calculates the weighting coefficients m in such a manner that signal interference resulting from the CDMA transmitted signals emitted to the other subscribers is suppressed or overcome. In the process, the channel estimation

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circuit 20 estimates the transmission channel H at the chip clock level T_c , and not at the data symbol level T_b .

- 5 The stored spreading codes for the other subscribers
allow the CDMA receiver according to the invention to
carry out multi-subscriber detection, which takes
account not only of the intersymbol interference but
also of multiple-access interference, and hence has
10 improved spectrum efficiency.

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List of reference symbols

	1	Antenna
	2	Line
5	3	Output node
	4	Line
	5	Signal input
	6	Rake receiving circuit
	7 ₁ -7 _n	Delay devices
10	8 ₁ -8 _n	Signal lines
	9 ₁ -9 _n	Signal lines
	10 ₁ -10 _n	Multiplication circuits
	11 ₁ -11 _n	Lines
	13	Weighting circuit
15	14 ₁ -14 _n	Signal lines
	15	Combiner
	16	Output line
	17	Output circuit
	18	Line
20	19	Line
	20	Channel estimation circuit
	21	Line
	22	Memory read line
	23	Memory device

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Patent Claims

1. CDMA receiver for receiving a CDMA signal, which is transmitted at the chip clock rate from a transmitter via various signal paths of a physical transmission channel, in a multi-subscriber environment having:
- 5 (a) a receiving device (1) for receiving the CDMA signal;
 - (b) a Rake receiving circuit (6) having a number of parallel-connected delay devices (7_1-7_n) for detection of the signal components of the CDMA signal which are transmitted via the various signal paths;
 - 10 (c) a channel estimation circuit (20) for estimating channel coefficients h of a transmission channel H by means of a predetermined reference data sequence which is contained in the received CDMA signal;
 - 15 (d) a weighting coefficient calculation device for calculating weighting coefficients m for the various signal components of the CDMA signal as a function of the estimated channel coefficients h and of stored spreading and scrambling codes;
 - 20 (e) a weighting circuit (12) for weighting the signal components with the calculated weighting coefficients m ; and having
 - 25 (f) a combiner (15) for combining the weighted signal components to form an estimated received data signal.
2. CDMA receiver according to Claim 1, characterized
- 30 in that the weighting coefficient calculation device (12) is connected to a memory device (23).
3. CDMA receiver according to Claim 1 or 2, characterized
- 35 in that spreading codes C_{sp} of the subscriber and scrambling codes C_{sc} from the transmitter are stored in the memory device (23).

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4. CDMA receiver according to one of the preceding claims,
characterized
in that the combiner (15) is an adder for adding the
5 weighted signal components.
5. CDMA receiver according to one of the preceding claims,
characterized
10 in that the reference data sequence is processed by the channel estimation circuit (20) at the chip clock rate T_c .
6. CDMA receiver according to one of the preceding claims,
15 characterized
in that the delay devices (7_1-7_n) of the Rake receiving circuit (6) delay the received CDMA signal by an associated time delay τ , with the time delay τ differing
20 by precisely one chip clock cycle T_c between the various delay devices.
7. CDMA receiver according to one of the preceding claims,
25 characterized
in that the receiving device (1) is a receiving antenna, which is followed by a sampling circuit for sampling the CDMA received signal.
- 30 8. CDMA receiver according to one of the preceding claims,
characterized
in that an output circuit (17) is provided for outputting the reference data sequence from the
35 received CDMA received signal.
9. CDMA receiver according to one of the preceding claims,
characterized

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

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INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS

(43) Internationales Veröffentlichungsdatum
26. Juli 2001 (26.07.2001)

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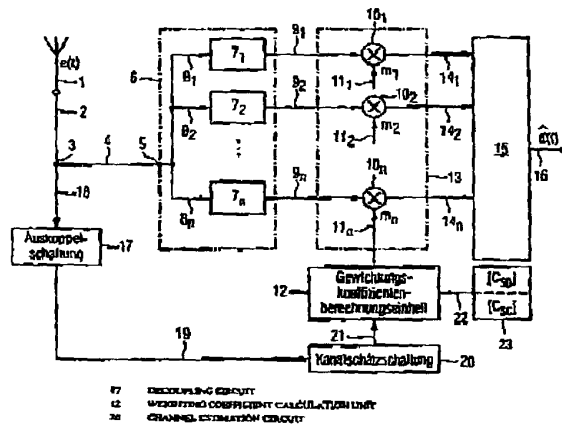
(10) Internationale Veröffentlichungsnummer
WO 01/54322 A2

- (51) Internationale Patentklassifikation: H04B 17/07 (71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von US): INFINEON TECHNOLOGIES AG [DE/DE]; St. Martin-Strasse 53, 81669 München (DE).
- (21) Internationales Aktenzeichen: PCT/EP01/00494
- (22) Internationales Anmeldedatum: 17. Januar 2001 (17.01.2001) (72) Erfinder; und (75) Erfinder/Anmelder (nur für US): DOETSCH, Markus [DE/CH]; Haselozweg 26, CH-3098 Schliern (CH). KELLA, Tadeya [CM/DE]; Tumbingerstrasse 54/42, 80337 München (DE). SCHMIDT, Peter [DE/DE]; Bahnhofstrasse 32, 67167 Erpolzheim (DE). JUNG, Peter [DE/DE]; Im Rabental 28, 67697 Okerberg (DE). FLECHINGER, Joerg [DE/DE]; Westermühlstrasse 16, 80469 München (DE). SCHNEIDER, Michael [DE/DE]; St. Martin-Strasse 44A, 81541 München (DE).
- (25) Einreichungssprache: Deutsch
- (26) Veröffentlichungssprache: Deutsch
- (30) Angaben zur Priorität: 100 01 649.9 17. Januar 2000 (17.01.2000) DE

[Fortsetzung auf der nächsten Seite]

(54) Title: CDMA RECEIVER

(54) Bezeichnung: CDMA-EMPFÄNGER



(57) Abstract: The invention relates to a CDMA receiver for receiving, in a multiple subscriber environment, a CDMA signal transmitted with a chip rate by a transmitter via different signal paths of a physical transmission channel. Said CDMA receiver comprises: a receiving device (1) for receiving the CDMA signal; a rake receive circuit (6) with a number of parallelly connected delay devices (7₁-7_n) for detecting the signal components of the CDMA signal that are transmitted via the different signal paths; a channel estimation circuit (20) for estimating the channel coefficients h of a transmission channel H by using a predetermined reference data sequence contained in the received CDMA signal; a weighting coefficient calculation device for calculating weighting coefficients m for the different signal components of the CDMA signal according to the estimated channel coefficients h and to the stored spread codes and scrambling codes; a weighting circuit (12) for weighting the signal components with the calculated weighting coefficients m ; and a combiner (15) for combining the weighted signal components to form an estimated received data signal.

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(57) Zusammenfassung: CDMA-Empfänger zum Empfangen eines mit Chiptakt von einem Sender über verschiedene Signalfade eines physikalischen Übertragungskanaals übertragenen CDMA-Signals in einer Mehrteilnehmerumgebung mit: einer Empfangseinrichtung (1) zum Empfang des CDMA-Signals; einer Rake-Empfangsschaltung (6) mit mehreren parallel geschalteten Verzögerungseinrichtungen (7₁-7_n) zur

[Fortsetzung auf der nächsten Seite]

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in that the weighting circuit (13) comprises a large number of multiplication circuits (10_1-10_n), which are each followed by a delay device (7_1-7_n).

5 10. CDMA receiver according to one of the preceding claims,
characterized
in that a buffer store is provided for buffer storing
the sampled received data from the CDMA received
10 signal.

11. CDMA receiver according to one of the preceding claims,
characterized
15 in that the channel estimation circuit (20) is a DSP processor.

12. CDMA receiver according to one of the preceding claims,
20 characterized
in that the weighting coefficient calculation device (12) is a DSP processor.

13. CDMA receiver according to one of the preceding
25 claims,
characterized
in that the memory device (23) is an RAM memory.

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FIG 1

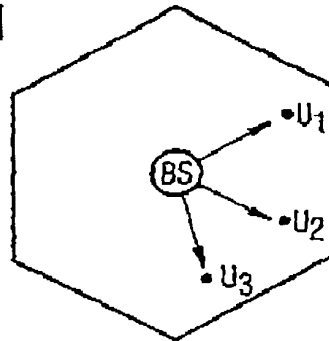


FIG 2

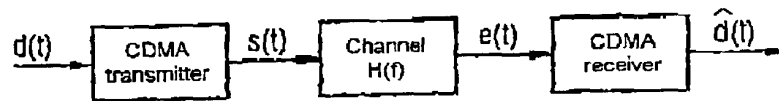
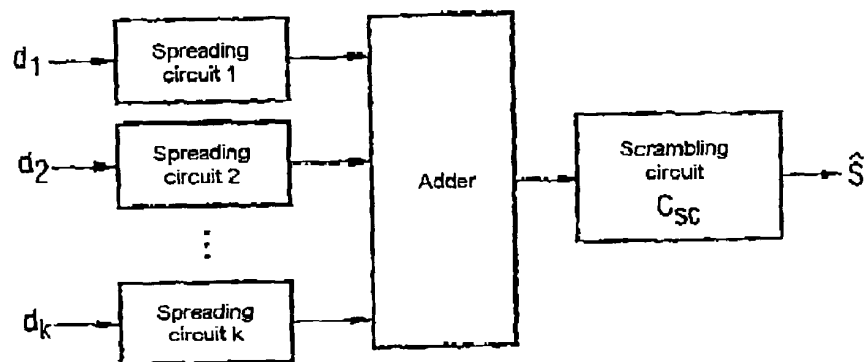


FIG 3

Prior art



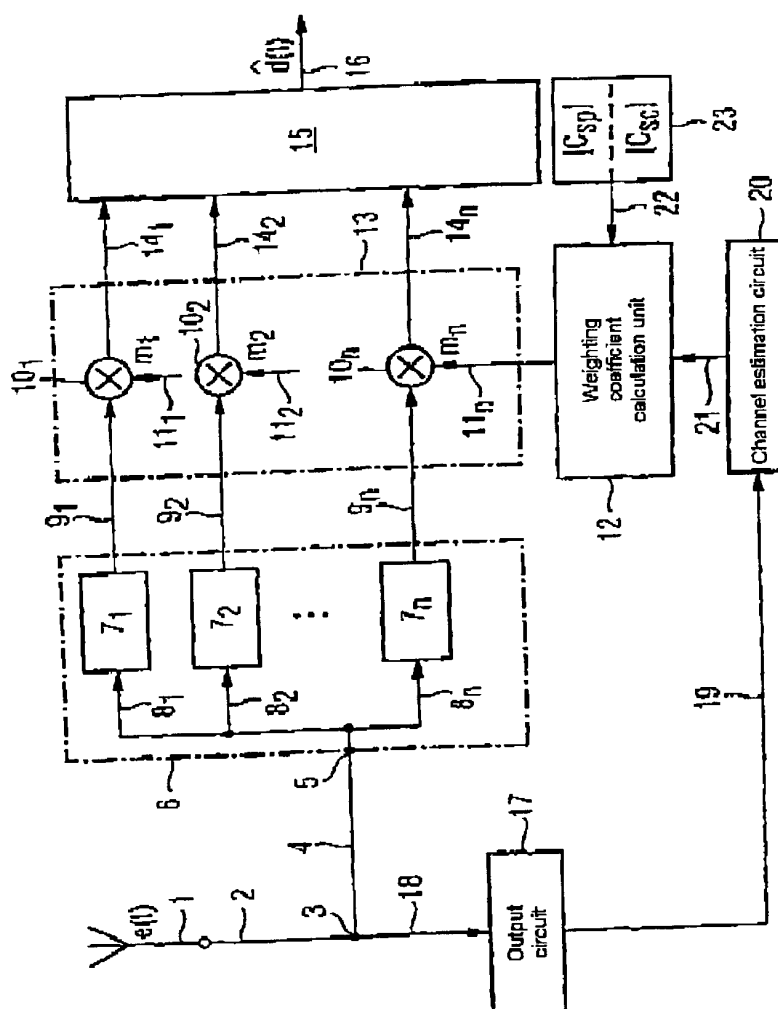
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FIG 5



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	First Named Inventor	Doetsch, Markus
	COMPLETE IF KNOWN	
	Application Number	09 / 936,771
	Filing Date	September 14, 2001
	Group Art Unit	
		Examiner Name

As a below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

CDMA RECEIVER

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 09/14/2001 as United States Application Number or PCT International

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I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

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100 01 649.9 PCT/EP01/00494	Germany WIPO	01/17/2000 01/17/2001	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
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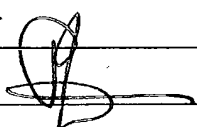
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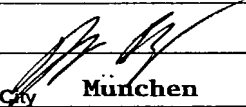
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Mailing Address			
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Mailing Address			
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